NISTIR 6327

Modelling Service Life and Life-Cycle Cost of Steel-Reinforced Concrete

Report from the NIST/ACI/ASTM Workshop held in Gaithersburg, MD on November 9-10, 1998

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Ray Kammer, *Director*

cement-based materials. The fact that the database resides on a different computer than the CIKS itself illustrates the feasibility of a distributed knowledge system using the World Wide Web. The second database is a compilation from the literature of concrete chloride ion diffusivity coefficients, along with mixture proportions and curing times, when provided.

The prototype shows the potential of employing a CIKS in the design process. A variety of different trial mixture proportions can be evaluated quickly with respect to their expected service life for chloride-ion-induced corrosion, and also with respect to their susceptibility to thermal cracking via the projected adiabatic temperature rise. The diffusion coefficients predicted by the computer can be compared to those in the existing experimental results database.

The potential of the Web for disseminating knowledge of concrete technology appears promising. Updating a CIKS on the Web, such as the prototype described, will become much simpler and quicker since only information on the server machine will need to be changed. Thus responses to user feedback will be able to be greatly expedited.

2.10 USING CONCRETE SERVICE LIFE PREDICTION MODELS TO ESTIMATE THE LIFE-CYCLE COSTS OF CONCRETE STRUCTURES

Mark Ehlen, National Institute of Standards and Technology

NIST's Building and Fire Research Laboratory has developed several economic techniques applicable to construction that have become ASTM standards. These include techniques for life-cycle costing and analytical hierarchical decision-making. The techniques have been applied in the development of the life-cycle costing software, BridgeLCC [25], for use in comparing new technology and traditional materials and systems for bridges on a common life-cycle economic basis. In the first instance, BridgeLCC was applied to bridge applications of fiber-reinforced polymer composites but, as part of NIST's Partnership for High-Performance Concrete Technology program, it is now being applied by several State Departments of Transportation to life-cycle costing of high-performance concrete (HPC) in bridges. The service life input is provided by the model described in the presentation.

BridgeLCC incorporates the NIST-developed life-cycle costing standard, ASTM E 917, Practice for Measuring Life-Cycle Costs of Buildings and Building Systems [26], and uses the NIST cost classification scheme. It can be used for sensitivity analyses, including Monte Carlo simulations. Examples of applications are: In building a new bridge, should steel, or conventional concrete, or high-performance concrete, be used in the girders? Or, for an existing bridge, should it be repaired or replaced? Should it be painted now or painted later? In applying BridgeLCC to the life-cycle cost of a bridge, the model addresses all bridge-related costs that occur during construction, e.g., maintenance and repair, and disposal of the structure (whether incurred by the agency, by the users of the bridge, or by affected "non-users"). All costs are discounted to a single number in present-day dollars using an interest rate formula.

The ASTM E 917 life-cycle costing standard covers a wide range of applications. Using a user-friendly, step-wise procedure, performance-based criteria allow evaluation of new materials and designs. Using the NIST classification scheme in a top-down approach insures that all costs can be accounted for. Using the scheme bottom-up, all costs can be properly placed, and the calculations can start with the engineer's estimate. The NIST cost categories are:

Characteristic 1: Who pays? The agency; the user; or a third party?

Characteristic 2: When does the cost occur? In initial construction? In operation, maintenance, and repair (OM&R)? Or in disposal?

Characteristic 3: What part of the project causes the cost? An element? A non-elemental factor (e.g., mobilization)? Or introduction of new technology (e.g., beam load test, NDE)?

Applying the NIST classification scheme in BridgeLCC, the technical advantages and disadvantages of a material can be assessed in economic terms. It should also be noted that BridgeLCC can be used to assess life-cycle costs on a probabilistic basis.

In an example, life-cycle analysis was carried out to compare a conventional concrete bridge with an high-performance concrete bridge and determine the life-cycle cost savings of using HPC instead of conventional concrete. It also showed how use of HPC would affect the initial construction costs and repair costs. For the HPC bridge, savings would result from use of fewer beams and from a longer-lasting deck.